Inequalities in hip fracture incidence are greatest in the North of England: regional analysis of the effects of social deprivation on hip fracture incidence across England

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Research approvals

We obtained NHS Research Ethics Committee approval for this study (REC reference: 15/LO/1056).

Disclosures statement

Arti Gauvri Bhimjiyani, Jenny Neuburger, Timothy Jones, Yoav Ben-Shlomo and Celia L Gregson have no disclosures.

Research Highlights

- This is the first population-based study of inequalities in hip fracture incidence across geographic regions in England.
- We examined the effect of deprivation on hip fracture incidence using 14 years of data for 747,369 hip fracture admissions.
- We determined that, after accounting for age, marked regional variation in hip fracture incidence exists across England.
- Absolute and relative inequalities in hip fracture incidence are greatest in the north of England.
- Our findings highlight the need for fracture prevention programmes aiming to reduce inequalities in hip fracture incidence.

Abstract

Objectives

Hip fracture risk varies by geography and by levels of deprivation. We examined the effect of local area-level deprivation on hip fracture incidence across nine regions in England, using 14 years of hospital data, to determine whether inequalities in hip fracture incidence rates vary across geographic regions in England.

Study design

Sequential annual cross-sectional studies over 14 years

Methods

We used English Hospital Episodes Statistics (2001/02-2014/15) to identify hip fractures in adults aged 50+ years and mid-year population estimates (2001-2014) from the Office for National Statistics. The Index of Multiple Deprivation was used to measure local area deprivation. We calculated age-standardised hip fracture incidence rates per 100,000 population, stratified by gender, geographic region, deprivation quintiles and time-period, using the 2001 English population as the reference population. Using Poisson regression we calculated age-adjusted incidence rate ratios (IRR) for hip fracture, stratified as above.

Results

Over 14 years we identified 747,369 hospital admissions with an index hip fracture. Age-standardised hip fracture incidence was highest in the North East for both men and women. In North England (North East, North West and Yorkshire & Humber), hip fracture incidence was relatively higher in more deprived areas, particularly among men: IRR most vs. least deprived quintile 2.06 [95% CI 2.00, 2.12] in men, 1.62 [1.60, 1.65] in women. A relationship, albeit less marked, between deprivation and hip fracture incidence was observed among men in the Midlands and South, but with no clear pattern among women.

Conclusions

Regional variation in hip fracture incidence exists across England, with the greatest absolute burden of incident hip fractures observed in the North East for both men and women. Across local areas in North England, absolute and relative inequalities in hip fracture incidence were greater than in other regions. Our findings highlight the need for improved fracture prevention programmes that aim to reduce regional and social inequalities in hip fracture incidence.

(word count – 316 words)

Keywords (3-6 keywords)

Hip fracture, index of multiple deprivation, epidemiology, health inequality, regional variation

Introduction

Hip fractures are an important public health problem, with significant impact on morbidity and mortality. Approximately 60,000 hip fractures occur annually in England,[1] and incidence is predicted to rise as our population ages. Hip fractures are costly with annual hospital costs estimated at £1.1 billion for the United Kingdom (UK).[2]

Worldwide geographic variation in hip fracture incidence is well-documented, with the highest rates reported in Northern Europe and the United States of America (USA).[3] Regional variation in hip fracture incidence rates has been demonstrated within New Zealand and the USA.[4, 5] Considerable regional variation in age-adjusted hip fracture incidence has been observed in the UK based on analysis of primary care data, with the lowest rates in London and the highest rates in the South West of England, Northern Ireland and Scotland.[6]

Greater deprivation has been associated with higher hip fracture rates in many high-income countries, including the UK. Analysing English Hospital Episodes Statistics (HES) we recently found that despite public health efforts to prevent hip fractures, amongst both men and women, greater deprivation predicts higher hip fracture incidence, and that, over the last 14 years, this health inequality gap has not narrowed for men, and has marginally widened amongst women.[7] However, it is unknown whether inequalities in hip fracture incidence rates differ between geographic regions in England and whether this has changed over time.

We hypothesised that inequalities in hip fracture incidence are not uniformly distributed across the geographic regions of England and that greater inequalities in hip fracture incidence would be observed in more deprived regions, in part potentially owing to variation in lifestyle risk factors for fracture. Hence, we examined the effect of area-level social deprivation on hip fracture incidence in England, across nine geographic regions, over a 14-year period.

Methods

We used HES data from all National Health Service (NHS) hospitals in England for the period 1st April 2001 to 31st March 2015 to identify patients aged 50 years and older with an index case of hip fracture on or during admission using International Classification of Diseases, Tenth Revision (ICD-10) disease codes for fracture of neck of femur (S72.0), pertrochanteric fracture (S72.1), and subtrochanteric fracture (S72.2). We excluded patients aged under 50 years in whom hip fractures are primarily due to high-impact trauma, and those with missing data (n=4,667) for age, gender, Index of Multiple Deprivation (IMD) or region of residence. We used Office for National Statistics annual mid-year population estimates for England from 2001 to 2014 as population denominators, stratified by age, gender, IMD quintiles and 9 Government Office Regions (GORs). We categorised the 9 GORs into 3 geographic regions: North of England (North East, North West and Yorkshire & Humber), the Midlands (East Midlands, West Midlands and East of England) and South of England (South East, South West and London). The IMD is a relative measure of socio-economic deprivation for local areas comprising seven domains of deprivation. We categorised patients into deprivation quintiles based upon the national ranking of their local residential area, with quintile 1 being the least deprived, and quintile 5 the most deprived group.

We used direct standardisation to calculate age-standardised hip fracture incidence rates per 100,000 population for men and women, stratified by geographic region and IMD quintiles, using the 2001 English population as our reference population structure; age-standardised hip fracture incidence rates, further stratified by time-period, were calculated to assess secular trends. We also calculated age-standardised rates for individual GORs using the same approach. To describe the association between local area deprivation and hip fracture incidence stratified by geographic regions, separately for women and men, we fitted Poisson regression models with the number of hip fractures per group as the dependent variable and IMD quintile and age as independent variables, including the population size as an offset. Associations are presented as Incidence Rate Ratios (IRRs) with 95% confidence intervals. All statistical analyses were conducted using Stata, version 14 IC (StataCorp, College Station, TX, USA).

Results

We identified 747,369 people admitted to hospital with a hip fracture over 14 years. Three quarters (74.2%) were women and the median age was 83 years; 81 in men and 84 in women. A fifth (19.2%) occurred among individuals in the least deprived quintile and just under a fifth (18.8%) among those in the most deprived quintile.

Age-standardised hip fracture incidence was higher in women than in men, and higher among people living in the most deprived compared to the least deprived local areas.

Regional variation in hip fracture incidence

Overall, age-standardised hip fracture incidence was highest in the North East (343 hip fractures per 100,000 population) and lowest in London (279 per 100,000). In men, age-standardised hip fracture incidence was highest in the North East (230 per 100,000) and lowest in the East of England (192 per 100,000), whilst among women, incidence was highest in the North East (414 per 100,000) and lowest in London (330 per 100,000) (figure 1).

Regional variation in hip fracture incidence by deprivation

The association of deprivation with age-adjusted hip fracture incidence was strongest in the North of England, with a dose-response pattern observed in both men and women (figure 2). A less marked relationship between deprivation and hip fracture incidence was observed among men in the Midlands and the South, with no clear pattern seen among women residing in these regions (figure 2). Age-standardised hip fracture incidence was highest in the North compared to the Midlands and the South for both women and men, and particularly in the most deprived local areas (table 1).

When analysed within the nine individual GORs, greater levels of deprivation were associated with higher hip fracture incidence in the North East, North West, Yorkshire & Humber, East Midlands, West Midlands and London, for both men and women. Amongst men, patterns in the South East and South West were similar (supplementary table 1). In contrast, the opposite association between deprivation and hip

fracture incidence was observed amongst women living in the East and South East of England, and amongst men in the East of England, where hip fracture incidence was lower among people living in more deprived local areas.

Secular trends in hip fracture incidence by deprivation and region

In men, age-standardised hip fracture incidence increased across all strata of deprivation and all geographic regions between 2001 to 2014, except for more deprived men in the North and the least deprived men in the South among whom hip fracture incidence remained relatively stable (figure 3a). The greatest increase in age-standardised hip fracture incidence was observed among the least deprived men in the North and the most deprived men in the South; however, the rate of this increase in hip fracture incidence declined over the study period. For example, among the most deprived men in the South, hip fracture incidence increased by 30 hip fractures per 100,000 men between 2001-2005 and 2006-2010, and by 8 hip fractures per 100,000 men between 2006-2010 and 2011-2014 (supplementary table 2).

From 2001 to 2014, age-standardised hip fracture incidence decreased in women of all strata of deprivation and all geographical regions, except for the most deprived women in the Midlands and South in whom hip fracture incidence remained stable over time, and in the least deprived women in the North who showed a paradoxical increase in age-standardised hip fracture incidence over time (figure 3b). The greatest absolute decline in age-standardised hip fracture incidence was observed among the least deprived women in the South, decreasing from 387 to 296 hip fractures per 100,000 women between 2001-2005 and 2011-2014.

Discussion

This study examined the relationship between local area-based deprivation and hip fracture incidence in men and women aged 50 years and older in England, and its geographic regions, analysing data collected over a 14-year period. We found marked geographical variation in age-standardised hip fracture incidence rates across England; the absolute burden of age-standardised hip fracture incidence was greatest in the North East of England for both men and women, whilst hip fracture incidence rates were lowest in the East of England and London for men and women respectively. If age-standardised hip fracture incidence across all GORs was reduced to the level seen in the East of England in men and London in women, then each year across England 3,248 fewer (738 male and 2,510 female) hip fractures would be recorded. Furthermore, for both men and women, the relative effect of deprivation on hip fracture incidence was most marked in the North of England, where absolute inequalities in hip fracture incidence were greatest. There were an additional 129 fractures per 100,000 men and 175 per 100,000 women in the most versus least deprived quintile in the North; this contrasts with an additional 52 per 100,000 male and 11 per 100,000 female hip fractures in the South.

These observed regional patterns in hip fracture incidence are in keeping with the wider body of literature documenting a 'North-South divide' in England, in which the health experiences in northern regions are generally poorer than the average for England, with the reverse being true for southern regions, and where the Midlands is comparable to the 'average for England'.[8]

The clear North-South gradient in hip fracture incidence that we observed in England contrasts with a recent UK study analysing Clinical Practice Research Datalink (CPRD) records from 1988 to 2012, which reported English hip fracture incidence to be highest in the South West and lowest in London for both men and women.[6] Whilst we also observed crude hip fracture incidence to be high in the South West, second only to the North East, this pattern was no longer evident after standardising for age. The CPRD analysis was not age-standardised, which may account for our differing conclusions. In addition, we analysed individual-level data derived from secondary rather than primary care sources, and studied a 14-year period from 2001, whilst Curtis et al studied a 24-year period from 1988. Such earlier data periods

used ICD-9 codes to classify hip fractures whilst our analyses used ICD-10 codes. These methodological differences when defining the hip fracture populations may explain the differing findings from both studies.

Regional inequalities in hip fracture incidence across England may partly be explained by regional variation in lifestyle factors. Lifestyle factors such as heavy alcohol consumption and tobacco use are associated with an increased hip fracture risk in both men and women.[9, 10]A North-South divide in smoking prevalence was identified in household population survey data (2014-2016) with rates highest in the North East and lowest in the South East.[11] A similar geographic pattern was observed for high-risk alcohol consumption, with the highest prevalence in the North; however, prevalence was lowest in London and the Midlands.

Alternatively, regional inequalities in hip fracture incidence rates may reflect geographic differences in access to fracture prevention services through service delivery models such as Fracture Liaison Services (FLS). CPRD records (1990-2012) have shown prescription rates of oral anti-osteoporosis drugs (AODs), which aim to reduce fracture risk, vary across England with the highest prescription rates in the South West in both men and women, and the lowest amongst men in Yorkshire & Humber and amongst women in the East Midlands.[12] However, AOD prescription does not necessarily translate to medication adherence and whether adherence varies by region is unknown.

The Royal College of Physician's FLS-Database (RCP FLS-DB) facilities audit systematically appraises the organisation of FLSs in England and Wales with the aim of improving the quality of fragility fracture care.[13] Fewer than 50% of eligible sites in England participated in the first facilities audit in 2016, of which 65% (48/74) reported having a dedicated FLS, of which two thirds (31/48) of these were in the South of England.

A final explanation could be that area-based deprivation is more closely associated with individual deprivation in the North of England compared to the South or Midlands. This could also explain the unexpected relationship between lower levels of deprivation and higher hip fracture incidence in certain Eastern GORs. Internal migration patterns among older people could lead to a difference in the socioeconomic status of individuals over the greater part of their lives, relative to the deprivation of the area

they currently live in. The greatest movement among older people is away from London and towards the South East, South West and East of England.[14] Of all English regions, London has the highest percentage of older people living in the most deprived local areas, as defined by the IMD Income Deprivation Affecting Older People Index, that is the proportion of adults aged 60 years and older living in Pension Credit households.[15] It can be hypothesised that people living in relatively deprived areas within London can afford to migrate later in life to more affluent regions in the South and East of England; however, they convey an increased hip fracture risk due to earlier life exposures to lifestyle risk factors for fracture.

The growing prioritisation of secondary fracture prevention programmes and routine orthogeriatric input into hip fracture care in the UK over the last decade, may in part explain the declines in hip fracture incidence seen in women, although our findings would suggest that all men and more deprived women in the Midlands and South may not be realising equal benefit from such services. We have also demonstrated that for both men and women in the North of England, those who are least deprived have seen a progressive increase in age-standardised hip fracture incidence; the explanation for which remains unclear. The development of FLSs was recommended as part of the Department of Health's Prevention Package for Older People (2009) to improve fracture prevention.[16] The implementation of initiatives such as the National Hip Fracture Database in 2007 and the associated Best Practice Tariff in 2010 aimed to improve the quality of hip fracture care;[17] however, we cannot exclude a secondary influence on the quality of clinical HES coding of hip fractures which may in part explain an increase in the number of recorded hip fractures over this period.[7] We reported that hip fracture incidence has decreased over time in women and increased in men;[7] an observation that has been supported by a recent analysis of UK CPRD data which showed that hip fracture incidence had similarly increased in men but plateaued in women.[18] The differential recording of hip fractures in HES according to gender and deprivation quintile is unlikely to explain the regional inequalities that we have described. Of note, we were unable to determine from HES codes, high *vs*. low-trauma fractures, nor very rare atypical femoral fractures.[19]

Conclusion

This is the first population-based study of inequalities in hip fracture incidence between and within geographic regions of England, using hospital administrative data collected over more than a decade. We have demonstrated that, after accounting for age, marked regional variation in hip fracture incidence exists across England, with the greatest absolute burden of incident hip fractures observed in the North East for both men and women. Furthermore, absolute and relative inequalities in hip fracture incidence linked to local area deprivation were greatest in the North of England for both men and women. Our findings highlight the need for fracture prevention programmes that aim to reduce regional and social inequalities in hip fracture incidence, with arguably the greatest need in the North of England. The RCP FLS-DB offers an opportunity to audit regional variation in such fracture prevention programmes.

Table legends

Table 1: Age-standardised hip fracture incidence rates per 100,000 population by quintiles of deprivation, overall and in men and women aged 50+ years residing in the North, Midlands and South of England, 2001-2014 (Quintile 1 (Q1) – least deprived quintile, quintile 5 (Q5) – most deprived quintile)

Supplementary Table 1: Age-standardised hip fracture incidence rates per 100,000 population by quintiles of deprivation, in men and women aged 50+ years residing in the 9 Government Office Regions of England, 2001-2014 (Quintile 1 (Q1) – least deprived quintile, quintile 5 (Q5) – most deprived quintile)

Supplementary Table 2: Secular trends in age-standardised hip fracture incidence rates per 100,000 population by quintiles of deprivation, in men and women aged 50+ years residing in England, 2001-2014 (Quintile 1 (Q1) – least deprived quintile, quintile 5 (Q5) – most deprived quintile)

Figure legends

Figure 1: Regional variation in age-standardised hip fracture incidence among men and women aged 50+ years residing in England averaged over a 14-year period (Numbers are incidence rates per 100,000 population)

*****North of England: North East (NE), North West (NW) and Yorkshire and The Humber (YH); †Midlands: East Midlands (EM), West Midlands (WM) and East of England (EE); ^South of England: South East (SE), South West (SW) and London (LD)

Figure 2: Geographical variation in the association between quintiles of deprivation and age-adjusted hip fracture incidence rate ratios in men and women aged 50+ years residing in England between 2001-2014 (Quintile 1 (Q1) (Least deprived quintile) – reference category) (95% confidence intervals presented)

(North (North East, North West and Yorkshire and The Humber); Midlands (East Midlands, West Midlands and East of England); South (South East, South West and London))

Figure 3: Secular trends in age-standardised hip fracture incidence rates per 100,000 population by quintiles of deprivation, in (a) men and (b) women aged 50+ years residing in England, 2001-2014 (Quintile 1 (Q1) – least deprived quintile, quintile 5 (Q5) – most deprived quintile)

(North (North East, North West and Yorkshire and The Humber); Midlands (East Midlands, West Midlands and East of England); South (South East, South West and London))

Poisson regression was used to assess trends in hip fracture incidence, adjusted for age group.

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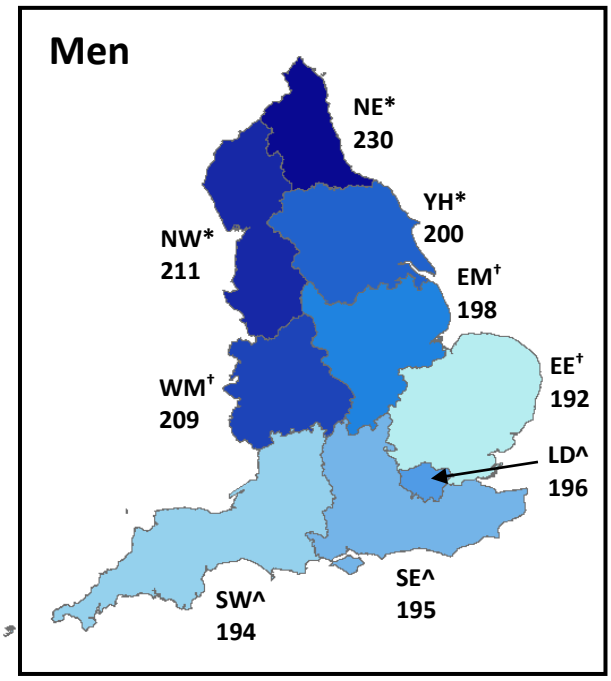
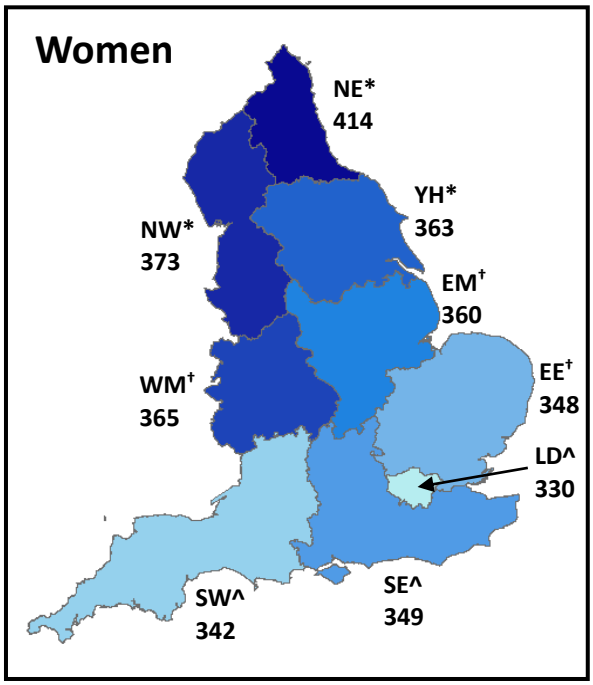
Table 1

IMD Quintiles	Overall		Men		Women	
	No. of cases	Rate/100,000 population	No. of cases	Rate/100,000 population	No. of cases	Rate/100,000 population
North						
Q1	26,341	217	6,679	142	19,662	267
Q2	36,328	268	8,937	174	27,391	331
Q3	40,696	315	9,892	204	30,804	384
Q4	48,288	354	12,040	240	36,248	423
Q5	71,125	379	19,220	271	51,905	442
Midlands						
Q1	44,328	283	11,463	185	32,865	352
Q2	53,433	306	13,570	202	39,863	375
Q3	52,453	289	13,398	194	39,055	352
Q4	43,893	298	11,275	205	32,618	357
Q5	36,567	299	10,063	216	26,504	349
South						
Q1	72,514	275	18,437	182	54,077	339
Q2	67,293	277	16,910	185	50,383	338
Q3	65,820	286	16,588	193	49,232	346
Q4	55,752	291	14,918	208	40,834	341
Q5	32,538	308	9,406	234	23,132	350

Figure 1


Men
NE*
230
YH*
200
NW*
211
EM†
198
EE†
192
WM†
209
LD^
196
SW^
194
SE^
195


Women
NE*
414
YH*
363
NW*
373
EM†
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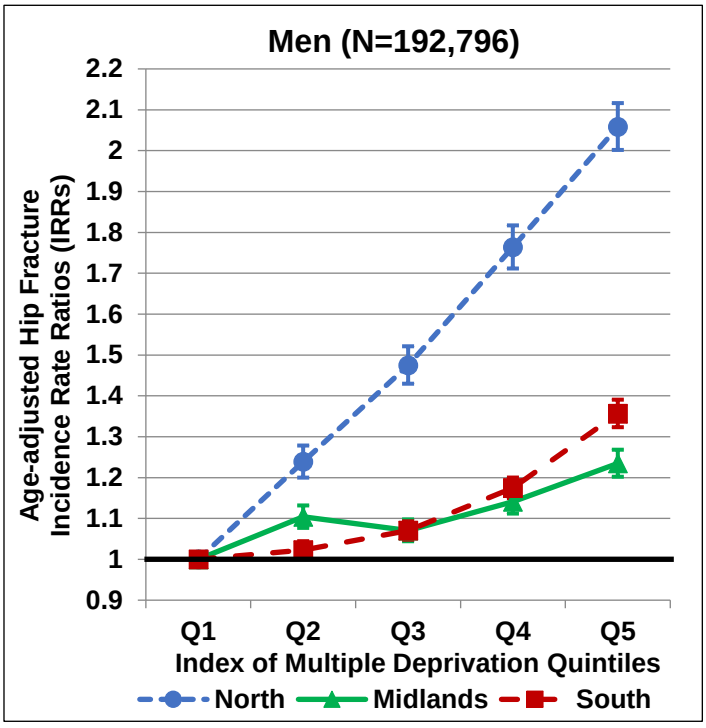
EE†
348
WM†
365
LD^
330
SW^
342
SE^
349

Figure 2


Men (N=192,796)
Age-adjusted Hip Fracture Incidence Rate Ratios (IRRs)
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
Q1
Q2
Q3
Q4
Q5
Index of Multiple Deprivation Quintiles
North
Midlands
South

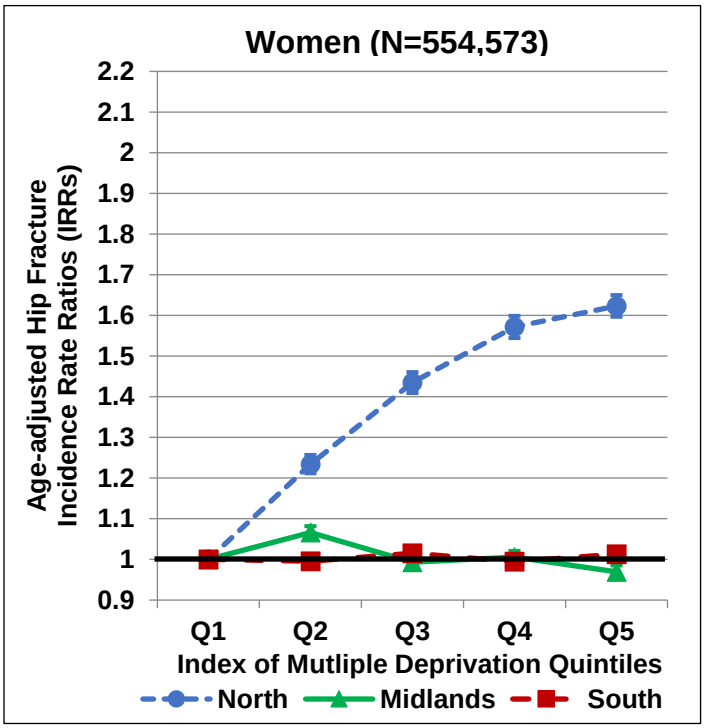

Women (N=554,573)
Age-adjusted Hip Fracture Incidence Rate Ratios (IRRs)
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
Q1
Q2
Q3
Q4
Q5
Index of Mutliple Deprivation Quintiles
North
Midlands
South

Figure 3a

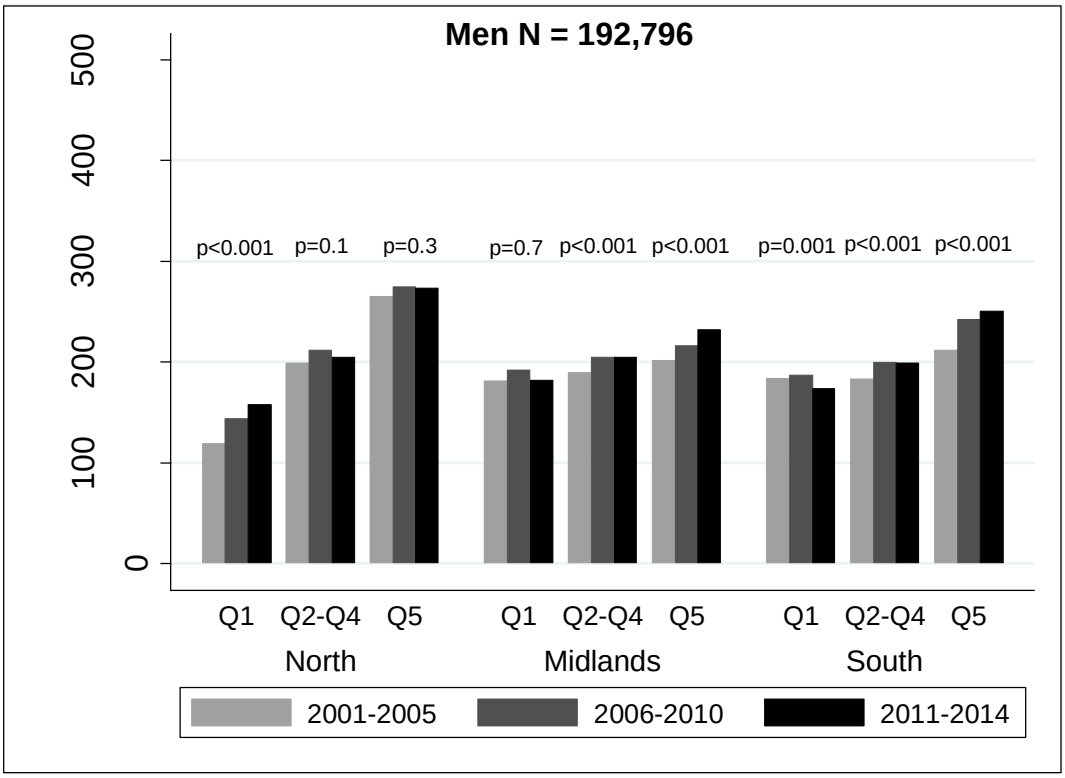
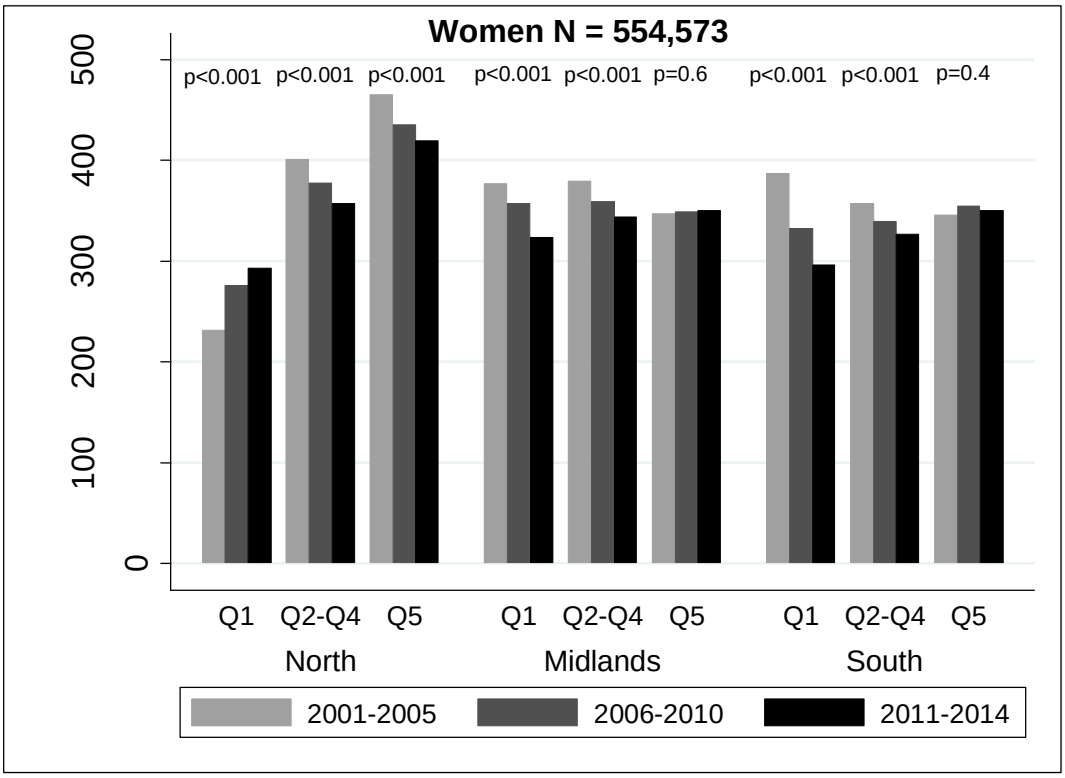

Men N = 192,796
0
100
200
300
400
500
p<0.001
p=0.1
p=0.3
p=0.7
p<0.001
p<0.001
p=0.001
p<0.001
p<0.001
Q1
Q2-Q4
Q5
Q1
Q2-Q4
Q5
Q1
Q2-Q4
Q5
North
Midlands
South
2001-2005
2006-2010
2011-2014

Figure 3b


Women N = 554,573
p<0.001
p<0.001
p<0.001
p<0.001
p<0.001
p=0.6
p<0.001
p<0.001
p=0.4
0
100
200
300
400
500
Q1
Q2-Q4
Q5
Q1
Q2-Q4
Q5
Q1
Q2-Q4
Q5
North
Midlands
South
2001-2005
2006-2010
2011-2014

Supplementary Table 1

North				
IMD Quintiles	Men		Women	
	No. of cases	Rate	No. of cases	Rate
North East				
Q1	832	113	2,567	231
Q2	1,405	181	4,114	326
Q3	1,751	224	5,477	424
Q4	2,655	245	8,188	451
Q5	4,368	318	11,897	518
North West				
Q1	3,368	149	9,557	270
Q2	4,148	172	12,614	326
Q3	4,508	205	14,131	384
Q4	5,429	242	16,190	419
Q5	9,237	268	24,626	435
Yorkshire and Humber				
Q1	2,479	144	7,538	278
Q2	3,384	173	10,663	338
Q3	3,633	196	11,196	367
Q4	3,956	234	11,870	411
Q5	5,615	248	15,382	407

Midlands				
IMD Quintiles	Men		Women	
	No. of cases	Rate	No. of cases	Rate
East Midlands				
Q1	3,180	183	9,025	344
Q2	3,607	177	10,687	339
Q3	3,473	205	10,073	369
Q4	3,494	215	10,152	387
Q5	2,903	225	7,817	371
West Midlands				
Q1	2,669	157	7,585	298
Q2	4,264	207	12,361	369
Q3	4,567	205	13,532	370
Q4	4,145	228	12,046	392
Q5	5,632	237	14,528	380
East of England				
Q1	5,614	204	16,255	390
Q2	5,699	218	16,815	407
Q3	5,358	181	15,450	327
Q4	3,636	177	10,420	304
Q5	1,528	155	4,159	250

South				
IMD Quintiles	Men		Women	
	No. of cases	Rate	No. of cases	Rate
London				
Q1	2,352	152	6,915	287
Q2	3,313	167	9,810	296
Q3	4,133	186	12,090	331
Q4	5,744	205	14,906	334
Q5	5,140	258	12,080	387
South East				
Q1	11,786	194	34,896	362
Q2	7,763	184	23,675	345
Q3	6,341	195	18,870	345
Q4	4,629	213	12,996	348
Q5	2,143	212	5,570	317
South West				
Q1	4,299	171	12,266	314
Q2	5,834	198	16,898	358
Q3	6,114	195	18,272	359
Q4	4,545	207	12,932	343
Q5	2,123	212	5,482	318

Supplementary Table 2

IMD quintiles		Males		Females	
	Time-period	No. of cases	Rate	No. of cases	Rate
North					
Q1	2001-2005	1,662	119	5,432	231
	2006-2010	2,446	144	7,260	276
	2011-2014	2,571	158	6,970	293
Q2-Q4	2001-2005	9,436	199	34,016	401
	2006-2010	11,371	212	33,494	377
	2011-2014	10,062	205	26,933	357
Q5	2001-2005	6,513	265	20,147	465
	2006-2010	6,938	274	18,124	435
	2011-2014	5,769	273	13,634	419
Midlands					
Q1	2001-2005	3,304	181	10,952	377
	2006-2010	4,253	192	11,932	357
	2011-2014	3,906	182	9,981	323
Q2-Q4	2001-2005	11,414	189	39,279	379
	2006-2010	13,972	204	39,641	359
	2011-2014	12,857	205	32,616	344
Q5	2001-2005	3,211	201	9,590	347
	2006-2010	3,613	216	9,387	349
	2011-2014	3,239	232	7,527	350
South					
Q1	2001-2005	5,677	183	20,193	387
	2006-2010	6,795	187	18,928	333
	2011-2014	5,965	174	14,956	296
Q2-Q4	2001-2005	14,719	183	50,768	357
	2006-2010	17,737	200	49,583	339
	2011-2014	15,960	199	40,098	327
Q5	2001-2005	2,948	212	8,403	346
	2006-2010	3,429	242	8,248	355
	2011-2014	3,029	250	6,481	350